

*The following seven papers were delivered as a symposium on "The Interaction of Native and Introduced Species in New Zealand."*

## THE INTERACTION OF NATIVE AND ADVENTIVE PLANT SPECIES IN NEW ZEALAND

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The probable and actual results of the interaction of native and adventive plant species in New Zealand have been and still are topics of considerable interest and discussion, and over the last one hundred and twenty years such eminent authorities as J. D. Hooker, W. T. L. Travers, Chas. Darwin, A. W. Wallace, T. Kirk, T. F. Cheeseman, G. M. Thomson, L. Cockayne, H. H. Allan and C. M. Smith have all contributed papers on different aspects of the subject.

In brief review, it can be stated that neither Hooker's original thesis that many small local genera would ultimately disappear owing to the usurping tendencies of the Northern Hemisphere adventives, nor the later prophecies which forecast large-scale displacement of the native vegetation by "all-conquering" adventives, was fulfilled; the true position has been clearly described by the last four authorities cited above. The marked diminution in total area of native vegetation and abundance of some native species was due, not to inherent superiority of the adventive species, but to actual physical destruction of, or modification of, the primitive vegetation by man and his associated agents — fire, cultivation, oversowing and grazing animals.

Allan (1931) pointed out that we have in New Zealand two floras and two vegetations, while C. M. Smith (1957) very pertinently stated that ". . . the local botanist is now witnessing the phase of modification of the initial pioneer communities of adventive plants, and the initiation of the much more advanced phase of communities composed of an amalgam of indigenous and adventive elements"; both writers made a plea for

intensive study of the second vegetation as well as the second flora.

With a primary interest in the adventive rather than the native flora, I am impressed not only by the number, abundance and widespread distribution of adventive plant species, but equally so by the tenacity and adaptiveness of a number of the native plant species; not only have some persisted despite vigorous competition from adventives and the operation of modifying factors, but they have demonstrated their ability to adapt themselves to much modified or entirely new habitats. The large-scale displacement of sown grassland (adventive species) over hill country of higher rainfall districts in both islands by such native species as *Acaena* spp., *Cassinia* spp., *Leptospermum* spp., *Paesia scaberula* and *Pteridium esculentum*, and the displacement of \**Ulex europaeus* communities by native broad-leaf forest, result from interactions as significant as any in the world; and just as significant as the perhaps more spectacular displacement of sown grassland communities by \**Ulex europaeus* and \**Erica* sp. communities.

Now I propose to consider several of these mixed native-adventive species communities, treating the significant species and the general character of the communities. These communities are treated in three main categories, based on the probable time of entry of the respective species into the community, and on the site or nature of the significant species.

\* Adventive species are marked with an asterisk throughout.

### SIMULTANEOUS ENTRY OF NATIVE AND ADVENTIVE SPECIES

#### *Ferns (Native) versus fern (Adventive)*

In the cracks of the timbering of creeks and drains about Christchurch exists an artificial habitat frequently occupied by linear fern communities; *Pteridium esculentum* and the European *Dryopteris filix-mas* appear simultaneously and over a period of years have maintained their relative abundance. Surprisingly, *Blechnum penna-marina* has entered in some instances, and despite the disparity in habit characters has held its status for at least six years. By contrast, the grass *Arrhenatherum elatius* has displaced *Epilobium* spp. in the same habitat in three years.

#### *Sedges (N) versus various herbs (A)*

The concrete gutters and channels of urban roadsides present an extensive specialised habitat. In this habitat a number of native species occur as casuals from time to time, but rarely persist in the permanent plant communities; but in a number of localities, *Elaeocharis* sp., *Scirpus americanus* and *S. cernuus* have assumed dominance over both annual and perennial adventives including *Agrostis* spp., *Alopecurus pratensis*, *Crepis capillaris*, *Epilobium* sp., *Juncus bufonius*, *J. articulatus* (syn. *J. lampocarpus*), *Mimulus* spp., *Poa* spp., *Sagina* spp. and *Taraxacum officinale*. In the north, these native species appear unable to displace the related *Cyperus rotundus* which grows well in such habitats, and dominance varied in the communities examined.

The artificial habitat of railway ballast, with mechanical disturbance at intervals and often periodic weedkilling, is one in which plant communities with many adventives might be expected. This is generally so, except that in higher rainfall districts one native species, *Carex ternaria* (of Cheeseman), has displaced the ruderal type of adventive element, giving in a short time pure communities devoid of adventives.

#### *Grass (N) versus various herbs (A)*

An unusual gutter-crack community in Christchurch shows *Poa breviculmis*, norm-

ally a grass of shaded, non-urban situations, competing in the open and in an artificial habitat with *Poa annua*, *Sagina apetala* and *S. procumbens*. Over a six-year period, *P. breviculmis* and *S. procumbens* have remained roughly static, *S. apetala* has decreased, while *Poa annua* has increased and at the same time developed a stoloniferous perennial habit.

### SUBSEQUENT ENTRY OF NATIVE SPECIES INTO ADVENTIVE PLANT COMMUNITIES

#### *Fern (N) versus various herbs (A)*

The berms of ditches, water-races and irrigation channels along roadsides on the dry Canterbury Plains provide an example of a native fern, *Blechnum capense*, coming in and establishing in extensive linear colonies, associated with such perennial adventives as *Agrostis* spp., *Bromus* spp., *Dactylis glomerata*, *Festuca rubra*, *Trifolium hybridum* and forms of *Mentha piperita*. This community might have been placed in the previous category, but I have seen it in process of development along water-ways which have had no major bank disturbance for years.

#### *Climbing shrub and under-shrub (N) versus spreading shrub (A)*

Just as efficiently as it establishes in native plant communities, *Muehlenbeckia complexa* enters and competes successfully in many places through the thousands of miles of planted *Ulex europaeus* hedges; it sometimes smothers the supporting shrub and replaces it with a dense mass of inter-twined branches. In this community *Muehlenbeckia* has come to be regarded as an important weed, because the tough wiry stems are difficult to cut, and foul the blades, arms and spindle of the mechanical hedge-trimmer.

In the Cheviot district, *Clematis afoliata* has come into hedgerows of *Crataegus monogyna* and *Lycium ferocissimum*, and over a ten-year period has covered many of the supporting shrubs. Examination shows seedlings in addition to mature plants of *Clematis* and time alone will show whether this two-plant community can maintain it-

self, or whether the climber will eventually smother out the supporting shrub.

*Broad-leaved herbs (N) versus grassy-leaved herbs (A)*

Domestic lawns and playing greens, often with artificial soil conditions and with recurrent close mowing and rolling, are good communities in which to watch the interaction of native and adventive species.

So successful have been the invading native species in this artificial habitat, that the acceptance of the so-called "weed greens" and "weed lawns" by householders and turf-users alike is a tribute to the ability of certain native species to adapt themselves to entirely new conditions and usurp the adventive vegetation. Swards initially of *\*Agrostis tenuis* and *\*Festuca rubra* var. *commutata* (often with such volunteer plants as *\*Bellis perennis*, *\*Cerastium* spp., *\*Hypochaeris radicata*, *\*Plantago lanceolata*, *\*Sagina procumbens*, *\*Soliva* spp. and *\*Taraxacum officinale*, to mention but a few) are invaded and sometimes ultimately replaced by one or other of the following natives — *Centella uniflora*, *Cotula* spp., *Dichondra repens*, *Gnaphalium* spp., *Hydrocotyle americana*, *H. moschata*, *H. novae-zealandiae*, *Nertera granadensis* (syn. *N. depressa*), *N. setulosa*, *Oxalis corniculata*, *Plantago triandra*, *Pratia angulata*, and *P. perpusilla*. While representing diverse plant families, these plants have, with one exception, the common characteristic of creeping, rooting stems and the ability to increase their dominance in an adventive community and a peculiar habitat.

Some of these New Zealand native species have shown that they can enter similar communities outside New Zealand; and McClintock (1960) has recently reported the successful growth of some of them in lawns in the British Isles, with *Cotula dioica* as probably the most frequent representative.

Lawns and greens are commended for study as being of taxonomic as well as ecological interest: are the species of *Dichondra*, *Gnaphalium*, *Hydrocotyle* and *Oxalis* conspecific with those so-named overseas, are the plants in our lawns truly native or truly adventive, or are they in part native and part adventive?

SUBSEQUENT ENTRY OF ADVENTIVE SPECIES  
INTO NATIVE PLANT COMMUNITIES

*Short-lived annual (A) versus ephemeral annual (N)*

Truly ephemeral species in the New Zealand flora are rare, and the presence of one as a significant member of a community seems worthy of mention. On what would appear to be denuded hillside basins in parts of Central Otago, there exists in spring to early summer a mixed community of *Myosurus minimum* and the Chilean *\*Amsinckia augustifolia*, with occasional relict plants of an umbellifer (*Oreomyrrhus?*) and scattered plants of *\*Hordeum murinum*. The ephemeral character of this small plant enables it to retain its co-dominance each year against a longer-lived, larger species.

*Annual and perennial herbs (A) versus annual and perennial herbs and shrubs*

The shingly, high-level terraces of the main North Canterbury rivers carry in many localities a vegetation characteristically annual, but with several perennial herbs and shrubs. One community of common occurrence is predominantly adventive: *\*Acaena ovina*, *\*Aira caryophyllea*, *\*Bromus mollis*, *\*B. tectorum*, *\*Cerastium glomeratum*, *\*Erodium cicutarium*, *\*Medicago hispida*, *\*M. minima*, *\*Rumex acetosella*, *\*Sedum acre*, *\*Stipa variabilis*, *\*Trifolium arvense*, *\*T. striatum*, *\*Tunica prolifer* and *\*Vulpia* spp., in which persist (but do not appear to spread) a meagre representation of natives — *Carmichaelia monroi*, *Danthonia* spp., *Geranium pilosum*, *Muehlenbeckia axillaris*, *M. ephedroides* and *Tillaea sieberiana*. This same community shows modification under the influence of periodic mowing in golf-course fairways — the native element persists with the exception of *Tillaea*, while the adventive element is markedly reduced in number of species.

*Tussock grass (A) versus modified low tussock grassland*

Modified low tussock grassland in parts of North Canterbury and Marlborough has been under invasion by a tussock, *\*Nassella*

*trichotoma*, for about half a century, and all stages of the mixed community from initial appearance to an ultimate replacement community of one species may be found. The pre-invasion community of relict *Poa caespitosa* and/or *Festuca novae-zealandiae* tussocks, sheltering a range of native and adventive herbs was cumulatively weakened by fire and grazing and a rigorous climatic regime, which promoted a dominance of short-lived adventive annuals, an increase in bare ground and corresponding lack of competition, and acceleration of invasion of *\*Nassella*.

The initial stage of establishment of this adventive was interesting, in that in the scattered tussock phase, the effect was the same as occurs with increase of the native tussocks — a greater amount of shelter for the ground layer and an increase in number of many of the inter-tussock species, both native and adventive. The community was dynamic, however, not static, owing to the continued operation of the modifying factors, and consequently it did not, and could not, remain at this stage. This adventive species was better adapted than any of the pre-invasion species of the community to increase its numbers, especially on the sunny north-west hill slopes; and with the progressive replacement of the other native and adventive species, a virtual one species, *\*Nassella trichotoma* community resulted, with occasional relict native or adventive plants.

This replacement community on the sunny face then in some instances brought into existence a further altered mixed community on the adjacent shady hill slopes. Because *\*Nassella* was unpalatable, stock were forced to graze more heavily on the communities on the sour or shady slopes, which at that stage were made up of a greater number of native species and more permanent adventive species. The heavier grazing and trampling reduced the vigour of the community, eliminated some species, and created conditions which allowed *\*Nassella* successfully to enter into the community.

#### *Gymnosperm (A) versus modified low tussock grassland*

Characteristic of the mixed communities discussed has been the not-too-great dispar-

ity in size of the members and in duration of the life cycle.

The entry of *\*Larix decidua* and *\*Pinus murrayana* into modified low tussock grassland has given mixed communities in which there are marked differences in size, general ecological characteristics, earliest age of reproduction and rate of reproduction of the significant species. The development of such communities is of necessity slower than in the types considered earlier, and time alone will reveal their ultimate character.

#### *Herbs and shrubs (A) versus ground and shrub layer, modified native forest*

The following communities are all found in remnants of modified native forest and provide some types which merit study.

#### *Herbs (A) versus ground layer species*

Examination of forest remnants in many North Island districts, especially of the type of small reserves on the flat which have suffered from grazing and mechanical damage from livestock, reveals instances of entry of *\*Selaginella kraussiana* or *\*Tradescantia fluminensis*, the latter particularly where floods are experienced. Where the ferns and seedlings of native species have been eaten out or trampled out, and a complete cover of one or other of the above-mentioned adventives has developed, it appears impossible for the ferns and seedlings of native species to enter into the community. Where destruction was not complete, these adventives gradually assumed complete dominance.

In Riccarton Bush, Christchurch, *\*Hedera helix* and *\*Iris foetidissima* form extensive colonies on the floor of a remnant of modified swamp forest and effectively prevent the growth of seedlings of native species. In one portion of this bush, a large colony of *\*Iris* has come in contact marginally with a similar sized colony of *Polypodium diversifolium* and over a six-year period neither spread into the other's territory.

#### *Shrubs (A) versus shrub layer species (N)*

In some North Island localities, following stock damage to the ground and shrub layer species, *\*Berberis darwinii* has entered in and appears, particularly where the canopy

is at all thin, to be capable of slowly gaining dominance over a range of native species.

Another ornamental, *\*Euonymus phello-mana*, has in parts of Riccarton Bush assumed dominance in the shrub layer and its seedlings are so abundant on the floor of the forest that many seedlings of native species are smothered. Flooding of the soil during the dry summer period may in this instance assist the native species to play a more vigorous part in the community, as it seems that lack of soil moisture during the summer over a number of years was a factor which placed the native members of the forest community as a whole at a disadvantage as compared with the adventive species.

#### *Climbers (A) versus climbers (N)*

A micro-community of the Asiatic *\*Lonicera japonica* growing with *Muehlenbeckia australis* and *Tetrapathaea tetrandra* is particularly interesting, and all three species are intertwined through and over lower trees of the canopy: after some years of observation the final results are still uncertain, although recent indications are that *\*Lonicera* appears the most vigorous.

Despite the patchiness of the communities described here, the following points may reasonably be drawn:

1. In the interaction of native and adventive plant species, representatives of both groups have shown their ability to become relatively permanent members of mixed communities and to become dominants.
2. Certain native species have shown that they can adapt themselves successfully to modified original or even new artificial habitats and communities.
3. Modifying factors may exercise marked effects on the behaviour of species.
4. Species belonging to both floras and differing markedly in botanical relationships, growth habit and original habit, have become significant members of a wide variety of mixed plant communities.
5. Many mixed communities are still in process of development.

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## SOME INTERACTIONS ON NATIVE AND INTRODUCED PLANTS IN NEW ZEALAND GRASSLAND

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A study of the history of the development of grassland in New Zealand is also a study of a prolonged interaction between native and introduced plants in which there has usually been a strong and deliberately guided bias towards the supremacy of the introduced plants. Because much of the native vegetation does not meet the requirements of the farmer, he has tried to replace this with plants that do so.

This programme of replacement has been dependent on many aids. Fire, axe, plough, fences, fertilisers and animals have all played a part. Much of this programme was carried out as described by H. Guthrie-Smith in *Tutira*: ". . . stamped, jammed, hauled, murdered into grass." Although this refers to the conversion of bracken fern country into grassland, it is typical of the action taken under many conditions to destroy the